

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): **Kobayashi**

Serial No.: N/A

Group Art Unit (of Parent Application): **1763**

Filed: **Herewith**

Examiner: N/A

Title: **Method of Fabricating a
Semiconductor Device**

Attorney Docket No.: **N230500C1**

PRELIMINARY AMENDMENT

5 Assistant Commissioner for Patents
Box Patent Application
Washington, D.C. 20231

Dear Sir:

10 Entry of the following amendments is respectfully requested.

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20
25
30 I hereby certify that this is being deposited with the U.S. Postal Service "Express Mail Post Office to Addressee" service under
37 CFR § 1.10 on the date indicated below and is addressed to:

35 Assistant Commissioner for Patents
Box Patent Application
Washington, D.C. 20231

By: Kobayashi

40 Typed/Printed Name: BRADLEY T. SAKO

Express Mail Label No.: EV183184639US

Date of Deposit: JANUARY 29, 2002

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In the Specification

Page 1, after the title, please insert the following paragraph.

This application is a **continuation** of patent application Serial No. **09/640,959** filed
5 **August 16, 2000.**

Please replace the paragraph beginning at Page 1, Line 20 with the following replacement paragraph.

10 Two common conductive materials that may be included in a semiconductor manufacturing process are aluminum and copper. Such materials have been included in interconnect patterns and the like. However, it has been difficult to form small and/or high aspect ratio contacts with aluminum. Similarly, while copper can provide advantageously low resistance, it is believed that many technical problems may have to be overcome before copper contact structures may be practically implemented. In view of the above drawbacks to materials such as aluminum and copper, many conventional contact forming methods include tungsten as a contact filling material.
15

20 Please replace the paragraph beginning at Page 16, Line 17 with the following replacement paragraph.

Referring now to FIG. 1D, a tungsten film **005** may be deposited over a layered film of titanium/titanium nitride (**003/004**). A tungsten deposition step may include a mixed gas that includes a tungsten source gas, such as tungsten hexafluoride (WF₆). In one particular 25 arrangement, a tungsten film **005** may be deposited with chemical vapor deposition techniques at a temperature of about 400 °C and a pressure of about 6 Torr. Such a tungsten (W) chemical vapor deposition (CVD) step may form a layer of tungsten **005** over a layered film of titanium/titanium nitride (**003/004**), thereby filling a contact hole **020**.

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In the Claims

Please cancel claims 1-20.

Please add the following new claims.

5 **21. (New)** A method of forming a contact plug, comprising the steps of:

selectively making a hole in an insulating layer that has a top surface, a side-wall surface being thereby formed in said insulating layer to define said hole;

10 forming a barrier layer on said insulating layer such that a first portion of said barrier layer on said top surface of said insulating layer is greater in thickness than a second portion of said barrier on said side-wall surface of said insulating layer, said second portion of said barrier layer defining a space corresponding to said hole;

15 depositing a conductive layer over said first and second portions of said barrier layer while filling said space;

20 etching back said conductive layer until said first portion of said barrier layer is exposed to thereby form a plug portion that fills said space and has a top surface which projects above said top surface of said insulating layer; and

25 removing said first portion of said barrier layer until said top surface of said insulating layer is exposed to thereby form a contact plug that fills said space and has a top surface which projects above said top surface of said insulating layer.

22. (New) The method as claimed in claim 21, wherein said barrier layer comprises a first metal film and said first metal film is formed by anisotropic sputtering.

25

23. (New) The method as claimed in claim 22, wherein said first metal film comprises titanium.

24. (New) The method as claimed in claim 22, wherein said anisotropic sputtering is performed in an ion metal plasma sputtering manner.

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25. (New) The method as claimed in claim 22, wherein said anisotropic sputtering is performed in a collimate sputtering manner.

26. (New) The method as claimed in claim 22, wherein said anisotropic sputtering is performed
5 in a long throw sputtering manner.

27. (New) The method as claimed in claim 22, wherein said barrier layer further comprises a second metal film that is formed on said first metal film by an isotropic sputtering.

10 28. (New) The method as claimed in claim 27, wherein said first metal film comprises titanium and said second metal layer comprises titanium nitride.

29. (New) The method as claimed in claim 27, wherein said anisotropic sputtering is performed in an ion metal plasma sputtering manner.

15 30. (New) The method as claimed in claim 27, wherein said anisotropic sputtering is performed in a collimate sputtering manner.

31. (New) The method as claimed in claim 27, wherein said anisotropic sputtering is performed
20 in a long throw sputtering manner.

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32. (New) A method of forming a contact hole, comprising the steps of:
- etching through a first insulating film to form a contact hole therein;
- depositing a first conductive film on the first insulating layer and a side inner surface of the contact hole;
- depositing a second conductive film on the first conductive film;
- depositing a third conductive film that fills the contact hole; and
- etching to expose the first insulating film around the contact hole and form a plug from the third conductive film that extends above a top surface of the first insulating film.

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33. (New) The method of claim 32, wherein
- the first conductive film comprises titanium; and
- the second conductive film comprises titanium nitride.
- 15
34. (New) The method of claim 32, wherein
- the third conductive film comprises tungsten.

- 20
35. (New) The method of claim 32, wherein
- the step of etching includes
- etching the third conductive film to a level below the first conductive film and above the first insulating film, and
- etching the first and second conductive films to expose the top surface of the first insulating film.

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36. (New) A method, comprising the steps of:

depositing first conductive film over a first insulating layer having a hole formed therein, the first conductive film being thicker over a top surface of the first insulating layer than on a side surface of the hole;

5 depositing a second conductive film over the first conductive film;

depositing a third conductive film over the second conductive film and within the hole; and

10 etching the third conductive film selective to the second conductive film to expose the second conductive film around the hole, the third conductive film being only within the hole and having a plug top that extends above the top surface of the first insulating layer but below a top surface of the second conductive film.

15 37. (New) The method of claim 36, further including:

selectively etching the first and second conductive films relative to the third conductive film to form expose the top surface of the first insulating film around the hole, the first and second conductive films being only within the hole.

20 38. (New) The method of claim 36, wherein

the hole is less than 0.3 microns wide.

25 39. (New) The method of claim 38, wherein

the hole is less than 0.25 microns wide.

40. (New) The method of claim 36, wherein

the step depositing the first conductive film is with an anisotropic method selected from the group consisting of ion metal plasma sputtering, collimate sputtering, and long throw sputtering.

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REMARKS

The Specification has been amended to address typographical errors.

All pending claims from the parent application have been cancelled.

Claims 21-40 are newly added claims.

5

Respectfully Submitted,

Krueger 1/29/2002

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Version With Markings to Show Changes Made

In the Specification.

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In the Claims.

21. (New) A method of forming a contact plug, comprising the steps of:

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10 forming a barrier layer on said insulating layer such that a first portion of said barrier layer on said top surface of said insulating layer is greater in thickness than a second portion of said barrier on said side-wall surface of said insulating layer, said second portion of said barrier layer defining a space corresponding to said hole;

15 depositing a conductive layer over said first and second portions of said barrier layer while filling said space;

20 etching back said conductive layer until said first portion of said barrier layer is exposed to thereby form a plug portion that fills said space and has a top surface which projects above said top surface of said insulating layer; and

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26. (New) The method as claimed in claim 22, wherein said anisotropic sputtering is performed in a long throw sputtering manner.

27. (New) The method as claimed in claim 22, wherein said barrier layer further comprises a second metal film that is formed on said first metal film by an isotropic sputtering.

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5

depositing a second conductive film on the first conductive film;

depositing a third conductive film that fills the contact hole; and

etching to expose the first insulating film around the contact hole and form a plug from the third conductive film that extends above a top surface of the first insulating film.

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